# Enhancing Early Childhood Literacy Through Game-Based Interactive Digital Media Development

Taopik Rahman[1], Yufiarti[2] and Yuliani Nurani[3]

**Abstract**

*Literacy skills are one of the important skills needed by early childhood. Digital games are one of the media that can be developed into teaching materials. As we know, games have developed into many types. In this case, the research aims to develop digital games that can be useful for improving early childhood literacy skills. The game that was developed was then assessed for its feasibility to become teaching material by media experts. the results of the research by the two media experts showed 79.50%, which means that digital games are feasible to use to improve students' literacy skills. After going through an expert assessment, the digital games are implemented to early childhood to see the level of readability of letters by students. In the implementation stage carried out by giving pre tests and post tests, there was an increase in the readability of letters by children. Then the N-Gain test was conducted to find out how effective digital games are for improving literacy in children. The results of the N-Gain test found that digital games are very effective for use in learning with an N-Gain score of 77%.*

**Keywords:** *Game-Based Interactive, Literacy Skills, Early Childhood Education.*

## INTRODUCTION

Education is an effort to develop human resources so that they have the information, competence, and high level of competitiveness required to address all global concerns. An approach that enhances the passion and active engagement of young children is necessary to foster this growth (Hepach, 2023). The most effective strategy to implement learning in early childhood education should be student-centered (Artner and Mecklenbrauker, 2020). Student-centered learning is necessary to psychologically engage students and achieve learning objectives effectively and efficiently (Evripidou, 2020; Saarinen et al., 2020; Zhu, 2022). Psychosocial engagement consists of several components, including one's attitude toward learning, motivations for learning, inclusion in learning, emotional well-being, and classroom conduct. These components indicate a strong association with academic success (Alonso-Tapia et al., 2022). Furthermore, involvement encompasses intellectual effort, active engagement, and emotional commitment to the learning process, resulting in an exceptional learning experience (Greener, 2022).

Besides using the right ways to learn, efforts to improve human resources can't be separated from all the resources that can help them, such as the results of fast technological progress (Timotheou, 2023; Chan, 2023; Kultsum et al., 2022). Technological development has long started in developed countries. This encourages Indonesia, as a developing country, to keep pace with these countries by actively updating and utilizing technological advancements in learning activities to foster effective learning (Purnomo et al., 2022). A previous study (Seenin et al., 2021) stated that a whole range of supporting components, including media, instructional materials, assessment systems, and other tools, are necessary to create effective learning. An essential aspect of fostering effective learning is the implementation of a complete approach that encompasses a range of supporting components. The components encompass instructional media and materials (Burkhardt and Schoenfeld, 2020).

Educators need to have high skills and creative power to create superior learning products (Keshav, 2022). These skills and creativity include: 1) the ability to combine media in learning; 2) the ability to manage large

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[1] Department of Early Childhood Education, Universitas Negeri Jakarta, Jakarta 13220, Indonesia. E-mail: TaopikRahman_9920917006@mhs.unj.ac.id. (Corresponding author)

[2] Department of Early Childhood Education, Universitas Negeri Jakarta, Jakarta 13220, Indonesia

[3] Department of Early Childhood Education, Universitas Negeri Jakarta, Jakarta 13220, Indonesia.

groups of students; 3) the flexibility to redesign according to the needs, context, and characteristics of each student; and 4) the ability to present a variety of learning media. To produce appropriate media, teachers must master the use of a variety of available and developed learning tools. They must master the use and development of media, resources, and instructional strategies that match their institution's requirements. To support the above abilities, a solid grasp of how to use educational media is critical. Apart from that, it is also important to understand the learning strategies suggested by Arum et al. (2020), who emphasize that choosing the right learning strategy is very influential. The strategy must be able to pique students' interest and focus while also taking into account their active participation in the educational process. Educators who understand this will be capable of assessing and modifying learning models to achieve optimal results (Arum, Ibrahim, Look at it, et al., 2020; Casta et al., 2021).

In the twenty-first century, literacy encompasses more than just reading and writing; it also incorporates the larger idea of information literacy (Muliyati et al., 2024). Early childhood reading skills are critical for children's overall development since they impact language acquisition, cognitive capacity, and future academic accomplishment (Weadman et al., 2022). Literacy development in childhood has a significant impact on academic achievement, self-confidence, social skills, and compassion (Xiao et al., 2023; Washington Nortey et al., 2020). This emphasizes the broader benefits of literacy development in young children (early life) (Li et al., 2021). According to preliminary research, Indonesia's early childhood literacy rate remains relatively low. Conventional learning techniques, where the teacher holds a dominant position in front of the class and restricts literacy content to "paper and pencils," along with a deficiency in learning media, can lead to children's reading skills falling short of expectations. This reinforces the low literacy rate in Indonesia, as Solihin (2020) highlights the reading emergency in the country, where 70% of young children have a lower competency level in reading. Thus, investing in early childhood literacy programs and aiding teachers in increasing literacy skills is crucial for laying the groundwork for children's future success (Chaitow et al., 2022).

Teachers' instructional approaches have been ineffective in strengthening reading skills in early childhood. Therefore, we must develop new learning media to bolster learning techniques that foster student-centered learning and play concepts. This viewpoint is consistent with that of Ndia et al. (2020) and Rinto et al. (2020), who argue that the development of innovative methods of instruction is dependent on a shift in paradigms in the learning process. The creation of innovative teaching techniques is based on a paradigm shift in the learning process that aims to improve students' active engagement, perception, and cognitive growth. Creative teaching strategies improve student happiness, innovation ratings, and overall teaching results (Moreno-Guerrero et al. 2020). These techniques improve students' cognitive comprehension while also benefiting their psychological well-being and academic success (Kossybayeva et al., 2022).

Immersive learning methods like augmented reality (AR), virtual reality (VR), and mixed reality (a combination of AR and VR) necessitate the use of devices that are compatible with these technologies, such as smartphones or laptops equipped with AR and VR capabilities (Erik et al., 2024). Nevertheless, at the early childhood education level, children typically lack access to or are unable to utilize gadgets equipped with such capabilities. This research focuses on the development of an educational game for the Android platform. The game is designed to be accessed by youngsters using smartphones with standard specs, and it is specifically adapted to their features and skills.

Educational games can enhance learning materials by increasing their engagement and motivating students to actively participate in educational activities (Muliyati et al., 2022). Using educational games is consistent with Edgar Dale's cone of experience hypothesis, which suggests that individuals are more likely to retain information when they are actively engaged in the learning process. Within this framework, individuals retain 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, and 70% of the information they come across. They express this retained information verbally and in writing, and 90% of it is directly applied in practice. Developing a literacy learning paradigm using digital games promotes active engagement and participation from young children, leading to improved learning results. This technique is endorsed by several learning theories, such as constructivism, behaviorism, cognitivism, social learning, and connectivism.

The study conducted by Hsiao et al. (2014) revealed that children's manual dexterity and creativity improved when they engaged with a digital learning environment centered on games. This research further validates that young children who utilize the ToES learning model surpass individuals who utilize conventional learning methods in terms of their learning outcomes. The study conducted by Hwang et al. (2013) demonstrates that instructional computer games have a positive impact on children's academic performance and their attitudes towards learning. Further investigation conducted by Shoesmith et al. (2019) and Kowaluk and Woźniewski (2019) emphasizes the efficacy of interactive games in enhancing children's physical activity levels and digital literacy skills.

As a result, developing game-based digital media for early childhood literacy learning is an important step in introducing innovative and effective learning approaches. Given the need to develop a learning model that differs from the ones used by teachers so far, the researchers developed a model for early childhood literacy learning through game-based digital media.

## METHOD

This research uses the Lee & Owens Model research model. Lee & Owens Model has five stages (Lee, 2004) : (1) Assessment/Analysis; (2) Design; (3) Development; (4) Implementation; and (5) Evaluation. This is the Lee & Owens Model. The subjects in this study are early childhood in Tasikmalaya City, West Java, who were enrolled in early childhood education programs, aged four to five, served as the research subjects. The study was carried out between January and May of 2024.

### Assessment/Analysis

In the first stage of the assessment / analysis section, an initial analysis is carried out, namely a needs analysis to find gaps. Through this stage, a summary of the early literacy education process that has been implemented so far can be obtained, including a) early literacy learning is carried out using a one-way method, teaching by only telling the shape and pronunciation of letter symbols; b) the use of media in learning is not optimal (only using images printed by the teacher himself); c) the size of the media used is very small so that students sitting at the back find it difficult to see the media. From the problems or gaps found, a solution is produced, namely making game-based learning media to improve the ability to read letters in early childhood.

### Design

The second stage is the design stage. This stage starts with create the conversation flow, storyboard, and application content script at this point. The architecture of Information Programming teams utilizes flowcharts as a guide while developing game systems. Flowcharts: Storyboards are created by game designers using user flows as a reference.
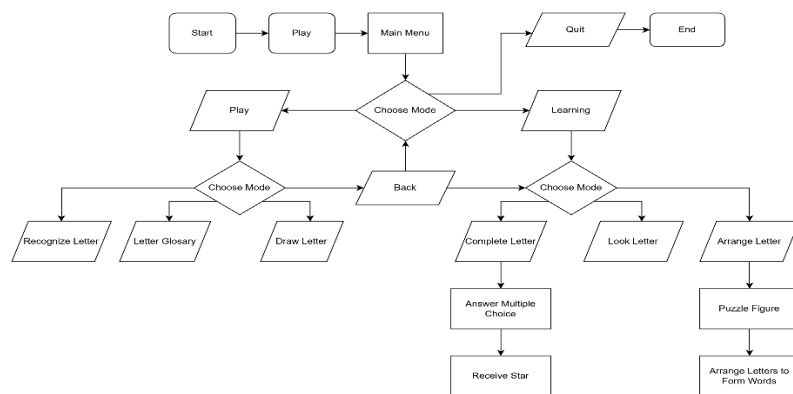


**Figure 1.** Information Architecture Flowchart & User Flow Flowchart

## Development

At the development stage, the media that has been made, goes through an assessment process by 2 media experts in their fields. the instrumen of the assessment by media experts are as follows.

**Table 1.** Instrument Test Results by Media Experts

| Aspect | Indicator | |
|---|---|---|
| Appearance | 1. | General appearance of the product |
| | 2. | Product initial appearance |
| Quality | 1. | The color combination used |
| | 2. | Appropriateness of font selection |
| | 3. | Appropriateness of using font size |
| | 4. | Accuracy of word/text proportion |
| | 5. | Sound clarity |
| | 6. | Appropriateness of music selection |
| | 7. | Music Audibly |
| | 8. | Placement of images |
| | 9. | Animations can function properly |
| Navigation | 1. | Clarity of commands in the navigation buttons |
| | 2. | Navigation key buttons function properly |
| Robustness | 1. | Product protection against viruses |
| | 2. | There is a pnoice in the product |
| | 3. | The application can be operated |
| Interface | 1. | Ability to interact between learners and the game |
| | 2. | Game products are familiar to users |
| | 3. | Appropriateness of feedback |

Product scoring system using a Likert scale with a range of 1-5 with the description as shown in Table 2.

**Table 2. Likert scale description**

| Score | Description |
|---|---|
| 1 | Very Bad |
| 2 | Bad |
| 3 | Good Enough |
| 4 | Good |
| 5 | Very Good |

The result obtained is calculated with the equation :

$$\bar{x} = \frac{\sum score\ obtained}{\sum score\ maximum}\ x\ 100\%$$

(1)

**Table 3.** Interpretation of product feasibility

| Percentage | Interpretation |
|---|---|
| $81\% \leq \bar{x} \leq 100\%$ | Very Feasible |
| $61\% \leq \bar{x} \leq 80\%$ | Feasible |
| $41\% \leq \bar{x} \leq 60\%$ | Feasible Enough |
| $20\% \leq \bar{x} \leq 40\%$ | Not Feasible |

## Implementation

The early childhood literacy learning model's efficacy through game-based digital media can be determined by analyzing pre-test and post-test data by carrying out the N-Gain test to determine the effectiveness of its use. with assessment result instrument:

**Table 4. Twenty-six letter readability assessment instrument**

| Aspect | Description |
|---|---|
| Twenty-six Letter Recognition | Ability to iden1tify and name each letter of the alphabet. Distinguishing between uppercase and lowercase letters. |

**Table 5.** Instrument of table for assessment

| | Student X | |
|---|---|---|
| | Good readability | Not read well |
| A | … | |
| B | … | |
| C | … | |
| … | | |

with a range of 0 -1 with the description as shown in Table 6.

**Table 6. Scale decsription**

| Score | Description |
|---|---|
| 0 | Not read well |
| 1 | Good readability |

The result obtained is calculated with the equation :

$$\bar{X} = \frac{\sum score\ obtained}{\sum score\ maximum}\ x\ 100\%$$

(2)

Quantitative data analysis strategies used N-gain scores by calculating the difference between pretest and posttest scores as well as qualitative data related to information descriptions, observation, interviews, and recording were the methods used for gathering data from observations, interviews, documentation, and validation.

**Table 7. Interpretation of Developmental Progress Scale of literacy skilss for Early Childhood**

| Percentage | Interpretation |
|---|---|
| $76\% \leq \bar{x} \leq 100\%$ | Developing Very Well (DVW) |
| $51\% \leq \bar{x} \leq 75\%$ | Developing as Expected (DAE) |
| $26\% \leq \bar{x} \leq 50\%$ | Beginning to Develop (BD) |
| $0 \leq \bar{x} \leq 25\%$ | Not Yet Developed (NVD) |

After the post test and pre test, the media used is tested for effectiveness using the N-Gain test with the interpretation as shown in Table 8.

**Table 8. Interpretation of N-Gain**

| N-Gain score | Interpretation |
|---|---|
| g > 0.7 | Effective |
| $0.3 \leq g \leq 0.7$ | Effective Enough |
| g < 0.3 | Not Effective |

## Evaluation

The evaluation stage is actually in each phase for each finding found when searching for data.

## RESULT AND DISCUSSION

The product produced in this research is a digital game equipped with animation and sound that can make early childhood interested in using this game to help improve literacy skills. generally, children really like something colourful, interactive and fun. Although in its use, children are not allowed to play cell phones for hours, but with the development of this digital game, children can play while learning, learn in a fun way and certainly do not miss the supervision of parents. In the development of this digital game, the preparation of storyboards, colour selection, models, icons, buttons, logos, and typography are part of the pre-production stage. if the appearance of the game and the storyboard or content of the game have been designed, then the next stage is to produce the game with a predetermined design to be assessed by experts and implemented to early childhood children with an age range of 4 - 5 years. In the development of this game, several computer software engineering, development specialists, such as game designers, game programmers, game managers, and 2D

game artists, collaborate with the production stage. The following image is the result of digital game development in this research



**Figure 2.** Main Menu



**Figure 3.** Menu to choose mode



**Figure 4.** Menu Learning Mode

**Figure 5.** Menu Playing Mode
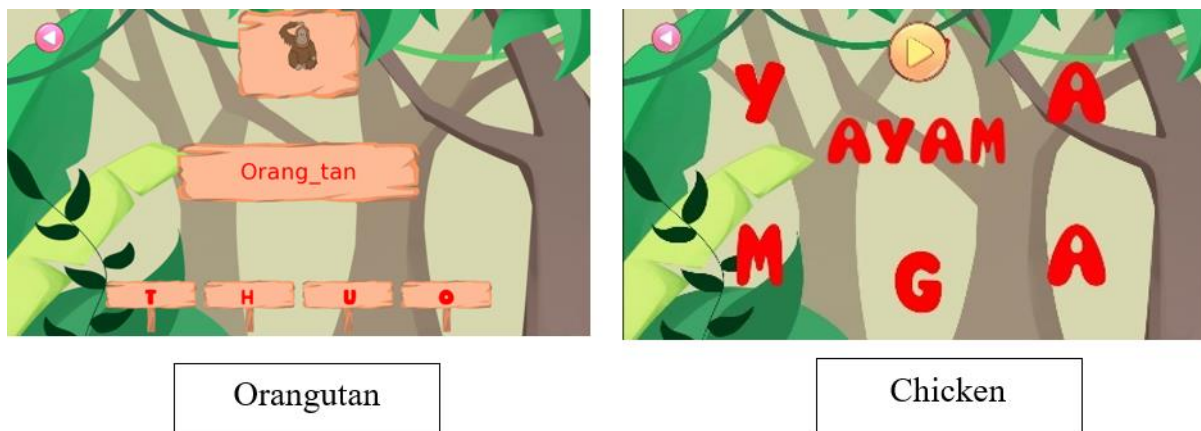


**Figure 6.** Learning Play Mode



**Figure 7.** Playing Mode

The game features two modes. play mode and learning mode. In each mode, there is an option to get to know letters more deeply while remaining colourful and interactive. Meanwhile, in play mode, 3 types of games are provided to help increase children's enthusiasm in learning letters through this digital game. At the end of each game, there is also a final score to determine the extent to which the child understands the letters.

After the media that has been made, goes through an assessment process by 2 media experts in their fields. the results of the assessment by media experts shown in Table 9.

**Table 9. Feasibility Test Results by Media Experts**

| Aspect | Expert A | Expert B | Average |
|---|---|---|---|
| Display/Presentation | 80% | 80% | 80% |
| Quality (text, sound, music, images and animation) | 80% | 82% | 81% |
| Navigation | 70% | 90% | 80% |
| Robustness | 80% | 80% | 80% |
| Interface | 73% | 80% | 76.50% |
| **Total Average** | | | **79.50%** |

The results of the feasibility test by media experts show that the product is suitable for use as a tool to improve the readability of letters by early childhood with a presentation of 79.50 by considering and revising the product.

**Table 10. Pre-test and Post-test results**

| Subject | Pre-Test | | | Post-Test | | |
|---|---|---|---|---|---|---|
| | Score | Percentage | Int | Score | Percentage | Int |
| Student A | 16 | 62% | DAE | 25 | 96% | DVB |
| Student B | 14 | 54% | DAE | 23 | 88% | DVB |
| Student C | 15 | 58% | DAE | 23 | 88% | DVB |
| Student D | 19 | 73% | DAE | 25 | 96% | DVB |
| Student E | 20 | 77% | DAE | 26 | 100% | DVB |
| Student F | 5 | 19% | NVD | 15 | 58% | DAE |
| Student G | 14 | 54% | DAE | 24 | 92% | DVB |
| Student H | 6 | 23% | NVD | 16 | 62% | DAE |
| Student I | 15 | 58% | DAE | 24 | 92% | DVB |
| Student J | 14 | 54% | DAE | 22 | 85% | DVB |
| Student K | 19 | 73% | DAE | 26 | 100% | DVB |
| Student L | 18 | 69% | DAE | 26 | 100% | DVB |
| Student M | 12 | 46% | BD | 23 | 88% | DVB |
| Student N | 13 | 50% | BD | 22 | 85% | DVB |
| Student O | 16 | 62% | DAE | 25 | 96% | DVB |
| Student P | 6 | 23% | NVD | 14 | 54% | DAE |
| Student Q | 20 | 77% | DAE | 26 | 100% | DVB |
| Student R | 8 | 31% | BD | 20 | 77% | DVB |
| **Mean** | **14** | **53%** | **DAE** | **23** | **87** | **DVB** |

After completing the pre-test and post-test, then calculating the N Gain value to measure the level of effectiveness.

| Descriptives | | | Statistic | Std. Error |
|---|---|---|---|---|
| Gain | Mean | | .7744 | .04317 |
| | 95% Confidence Interval for Mean | Lower Bound | .6833 | |
| | | Upper Bound | .8655 | |
| | 5% Trimmed Mean | | .7825 | |
| | Median | | .7937 | |
| | Variance | | .034 | |
| | Std. Deviation | | .18317 | |
| | Minimum | | .40 | |
| | Maximum | | 1.00 | |
| | Range | | .60 | |
| | Interquartile Range | | .25 | |
| | Skewness | | -.524 | .536 |
| | Kurtosis | | -.431 | 1.038 |

**Figure 8.** N-Gain test result

Based on the calculations carried out, the N-Gain Score of 0.77 and N-Gain Score (%) of 77.00% were obtained. This shows that the early childhood literacy learning model through game-based digital media is effective for improving early childhood literacy skills with an effectiveness value of 77.00% and is categorized with a very high level of effectiveness.

Finding out whether users (children and teachers) can understand the digital media application "Playing Literacy" is the goal of this activity. Implementation activities were carried out educational institutions in

Tasikmalaya City, West Java. As a result, When the teacher presented the "Playing Literacy" application to the kids, they were excited; 2) Kids can mimic how the letters in the application are pronounced; 3) Kids focus intently on the sounds and pictures in every application; 4) Kids can try again if they get the answer wrong; 5) Kids can use apps on their cellphones that the school provides; and 6) Generally, the amount of time kids spend using an application depends on the length of time they spend using each sub-material to avoid getting bored.

## CONCLUSION

Using the Lee and Owens model, which includes steps and descriptions of media displays appropriate for use at the early childhood education level, game-based digital media is developed to enhance the literacy of children aged 4-5. For usage on Android-powered PCs, the digital media application "Playing Literacy" is an example of a digital innovation product in the form of early childhood education media. Based on the outcomes, it is appropriate to utilize the digital resource "Playing Literacy" to enhance early childhood literacy. of expert validation tests. The results of field trials show that digital media has an N-Gain rating of 0.7744 and an N-Gain rating (%) of 77.00%. Thus, it shows that game-based digital media is effective in improving literacy skills in early childhood with an effectiveness value of 77.00% with very high level of effectiveness.

It is suggested that educators use this digital medium, which has been developed to increase the literacy of young children aged four to five years, based on the research results that have been given. to improve the literacy of early childhood. It is recommended that the use of digital media be carried out with the guidance of a teacher or parent. For future researchers and developers, it is necessary to develop early childhood literacy learning media through digital media with material covering all themes in early childhood to produce intelligent children in the future. However, the developed media still has shortcomings and limitations, namely the media is rather difficult to use by early childhood during the installation process, so the role of parents and teachers is needed for the program initiation process.

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